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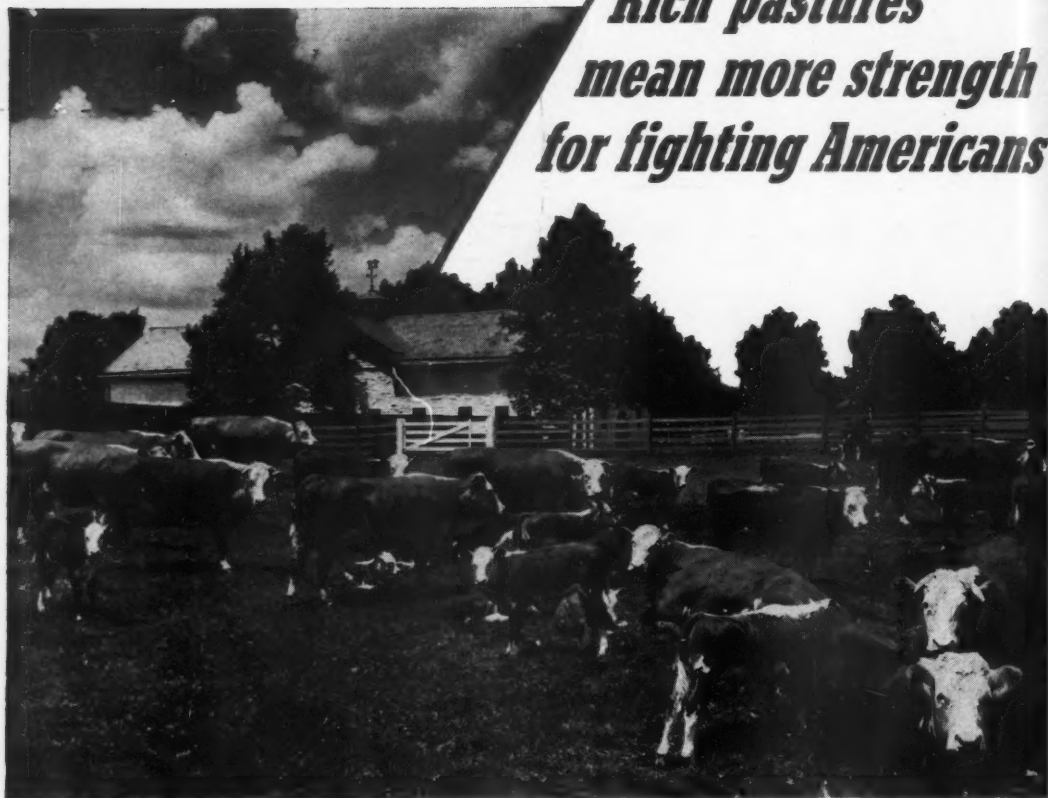
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See page 27



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AMERICAN FERTILIZER

"That man is a benefactor to his race who makes two blades of grass to grow where but one grew before."

Vol. 101

OCTOBER 7, 1944

No. 7

The Need for Borax on Fourteen Crops*

BY D. E. DUNKLEE AND A. R. MIDGLEY

Agricultural Experiment Station, Burlington, Vermont

FARMERS and vegetable growers have brought to our attention a number of crop troubles apparently nutritional in character. Since many of these troubles were suspected to be due to some phase of boron deficiency, we purposely boron-starved 14 important crops grown in the Northeast. These were grown on a very boron-deficient Vermont soil in order to more clearly recognize boron-deficiency symptoms under field conditions. The eventual objective is to find out what crops need borax and where it is needed as a farm fertilizer.

Plants starved for boron exhibit many diverse symptoms. The number of possible symptoms or phases of boron deficiency for each crop is almost unbelievable considering the small amounts of this element needed by plants. Burrell in relation to the apple describes at least five different symptoms (1) but apparently there are others.

We have obtained and corrected seven different symptoms of boron deficiency of alfalfa on a Vermont soil, namely, terminal dieback, rosetting, multiple branching, seed stripping, defective inflorescence, seedling death, and abnormal foliage coloration (4). The latter by some writers is called "yellows." Two other relatively unimportant symptoms, withered seed and root cankers, were also obtained and corrected. For alfalfa, no symptom corresponding to the "cracked stem" disease of celery has been observed, but such a symptom might exist.

We thus postulate that there can be at least all of these 10 different boron-deficiency symptoms for every kind of plant provided

the proper degree of boron deficiency is attained. The extent or degree of each symptom depends on the time boron deficiency overtakes the plant and at what stage crop growth is arrested. Knowing only one symptom per plant does not seem to be the final answer. Until someone has reached into the grab-bag of nature and pulled out all symptoms, experimentally, as they occur in farm practice, we can still expect surprises. The symptoms probably express themselves more or less independently of each other or several of them at the same time, as we have found for alfalfa.

Some symptoms for each crop have economic importance, others do not, probably because they are microscopic and not easily observed. The fact remains, however, that there are still many symptoms for each crop yet to be reported, and that investigators may have missed certain prevalent symptoms which often betray the field need for boron as a fertilizer.

A five-year search has been in progress at this Station to see what diverse crop symptoms of boron deficiency could be uncovered. The writers believe that boron-fixing soils found in the podzol region offer a fertile field for further crop research since they provide suitable media for obtaining different levels of boron deficiency under field conditions. The following experiments are offered as progress in this direction.

These experiments were conducted in field pots because of difficulties previously encountered in large field trials. For two seasons before they were started, attempts had been made to produce and correct clear-cut cases of boron deficiencies in the field with 14 important crops. Although the experiments were conducted on a field where

*Reprinted from *Better Crops with Plant Food*, August-September, 1944.

**Numbers in parentheses refer to Literature listed at end of article.

marked boron responses had been obtained with alfalfa, we had no luck in obtaining them with other crops, even though suspecting nutritional troubles were present. Difficulties encountered might have been due to either poor availability of borax, inability to control the level of the boron supply, unfavorable season, or lack of other necessary nutrients such as magnesium. At any rate, it seemed that more progress might be made on pioneer experiments if they were conducted in barrel-sized field pots, at least until the expected deficiency symptoms could be determined.

The field pots used were asphalt-painted metal ash cans, 18 inches in diameter and 2 feet deep, with holes in the bottom for drainage. The pots were sunk in the field, the top within two inches of the ground level. The possibility that plants might feed through the bottom was considered but dismissed as remote because of the character and depth of the soil employed.

These experiments were purposely to be conducted on a soil known to have a high capacity to fix boron, because it would permit growth to be arrested at many different stages, and permit the use of ordinary commercial fertilizers, even though they may carry some boron impurities. Sand cultures were purposely avoided because they would be more artificial and involve much more trouble to attain severe deficiencies.

The soil selected was a very boron-deficient podzol topsoil from Breadloaf, Vermont. When limed to neutrality it fixes considerable amounts of boron out of reach of the crop. This soil contains more than 90 per cent organic matter, and it has been found that this organic part fixes boron, apparently functioning as an organic zeolite.

The soil in all pots was limed to approximate neutrality with ordinary ground limestone, fertilized with an ordinary 8-16-16 commercial fertilizer at 1,000 pounds per acre, and epsom salt at 200 pounds to supply magnesium. The fertilizer was calculated for the full depth of soil and mixed with it. Except for boron, all pots were fertilized exactly alike.

Borax was added to every other pot at 100 pounds per acre. This rate of borax seems to be necessary to grow plants on this high-fixing soil. The other pots were left entirely without borax or, because of no growth at all, borax was later added to several at the very low rate of two pounds per acre in water solution. The purpose was to obtain field pots with and without borax, but otherwise generously and equally fertilized.

No irrigation was provided, rainfall being the only source of water for the crops, just as in field practice in this region.

Fourteen crops were planted—red and ladino clovers, timothy, oats, turnips, beets, carrots, sweet corn, lettuce, and string beans from seed, cabbage, broccoli and tomatoes from transplants, and potatoes from tubers. To fully eliminate genetic differences between potato seed pieces used, each seed tuber was cut through the stem end into equivalent sections. Half of each tuber went to the pot fertilized with borax, half to the pot without borax. This is really a tuber unit idea, a potato cut into equal units and a unit for each fertilizer treatment.* Potato seed pieces were thus approximately the same size and shape as used in farm practice. Soil was washed from roots of transplants to eliminate a carry-over of boron from the old to the new seedbed.

Since even in these experiments it was impossible to predict and control exactly the degree of boron deficiency and the age of the plant when growth was arrested, the symptoms reported represent only a few of the possibilities. They are striking but not necessarily the only ones sought. With many crops very outstanding boron deficiencies were obtained, as well as corrected, on this Vermont soil, although the symptoms were more severe than wanted.

Potatoes (Var. Green Mountain)

An extreme response to boron was obtained in spite of any boron which might have been carried in the seed pieces. Leaves of the boron-deficient potato plants appeared markedly rolled upward and were abnormally brittle and rough. They were suggestive of the potato leaf roll virus disease except for their pale dirty green coloration.

Potatoes with borax yielded 1,296 gms. of good tubers per pot; without borax, 52 gms. of small tubers which were absolutely worthless. This is a 25-fold increase in tuber yield from the use of borax on this soil. These extreme yield differences were obtained because the deficiency was very severe and because the deficient plants died when not more than nine inches high. However, the deficiency is not as extreme as it is possible to attain, because a two-year starvation with the elimination of boron from the seed piece should cause still more severe symptoms. We predict extreme variation in symptoms between the severe deficiency obtained and

*Tuber unit fertilization is a very useful procedure in other potato nutritional work to equalize genetic differences in seed.

those which overtake the potato plant after it is older.

Potato plants starved for boron suffered a severe attack of early blight while right beside them those receiving boron escaped it. This happened when the deficient plants were less than eight inches high. The fungus was identified in the field by Dr. Lutman, the Station Pathologist. Leaves of deficient plants rolled upward more than normally, were plastered with brown patches of this fungus, and were a dirty pale green in color.

In contrast, plants fertilized with borax were healthy, free of early blight fungus, lived until frost time, and produced a crop of clean, healthy tubers. Severe boron starvation thus fostered a clear-cut attack of early blight while borax in the fertilizer completely corrected it. This probably will happen again if the experiment is repeated, but of course the only way to be absolutely sure is to try it another year. Heinrich has also found that boron reduced the amount of potato blight (5). In a sense, our observation is confirmed by him although it is not clear whether he refers to late or early blight.

Bordeaux spray is commonly considered the remedy for early blight. Here, however, the attack occurred on the boron-deficient plants even though they had been well and frequently sprayed with a home-made 6-6-50 bordeaux. From this one experiment it would seem that boron in the fertilizer was very helpful in preventing the early blight of the potato. It should be remembered that both boron and bordeaux are antiseptic in their action and might both function in a similar way, although it is likely that lack of boron increased plant susceptibility to blight.

Boron-deficient tubers at digging time were more withered, rusty brown colored, and punky on the outside than potatoes that had been in the cellar for a year. The skin when cut was thick, corky, russeted, and finally cracked. Inside, the flesh was a solid rusty brown color except for a very small white area in the central part of the tuber. The vascular ring was obscured by browning. The tubers were very watery. None was larger than a golf ball. The watery internal condition indicated that the starch had not been accumulated in the tuber in the normal fashion. The brown internal color was the same shade as that causing net necrosis and stem-end browning of the potato. Further experiments are needed to determine what lesser degrees of boron deficiency look like midway between the solid browning we obtained, which severely dwarfed the tuber, and

the normal white internal condition. Until proved otherwise, there is a possibility that the right degree of boron deficiency might induce symptoms similar to net necrosis or stem-end browning in the tuber. One might think that what is known about net necrosis would eliminate a nutritional explanation. Nevertheless, present information might be merely fragments of the truth.

Turnips—Rutabagas

A marked response of turnips to borax was obtained. Without it, seedlings became straw colored and died when less than two inches high. The boron-deficiency symptom obtained in this case was the death of the seedlings. With borax, normal plants were obtained and continued to grow vigorously through the season. Yields, being meaningless, were not taken. In this case the deficiency was so severe that the turnips did not grow large enough to produce the characteristic brown heart usually reported as a result of boron deficiency.

String Beans (Var. Black Wax)

String beans responded markedly to borax. Without it, they quickly grew two leaves beyond the cotyledons and thereupon were attacked by fungous diseases. Although they made some further futile attempts to grow, no blossoms formed and no fruit was set. Growth was finally arrested midway between the seedling stage and flowering. Leaves were first dirty green, tending to become yellow and brown. With borax, normal growth was obtained, fungi did not attack, and the plants flowered profusely and produced a prolific crop of beans. Failures to form flowers, pods, and seed were the deficiency symptoms most obvious in this case. These symptoms were not as severe as the death of the seedling which has been obtained in other experiments on the same soil.

Red Clover

A marked size and stature response to boron was obtained with red clover. The actual symptoms of boron deficiency, however, were not conspicuous or outstanding. Without borax almost all of the leaves of the plant became characteristic lemon yellow colored (the same color as has been observed in boron-deficient alfalfa). Normal leaf markings were completely obscured on all leaves. Without borax some of the leaves were streaked, some had green veins with much yellow between, while others had the reverse coloring. In either case, leaf veins were more

(Continued on page 28)

The American Chemical Society

Abstracts of some of the Papers presented at the Meeting of the Division of Fertilizer Chemistry at New York City, September 11 to 15, 1944, H. B. Siems presiding.

Abstracts of other Papers were published in the August 26th and September 9th issues.

The Calcium, Magnesium, and Potassium Content of Alfalfa in Relation to the Soil on Which It Grew

Firman E. Bear and Arthur L. Prince, New Jersey Agricultural Experiment Station, New Brunswick, N. J.

The Ca content of first-crop alfalfa varied between 1.17 and 2.51 per cent when grown on twenty important New Jersey soils. Similarly, the Mg content varied between 0.19 and 0.49 per cent, and the K content between 1.50 and 2.90 per cent. As successive crops were harvested, the Ca and Mg content increased and the K content decreased. Thus the average Ca, Mg, and K content of the alfalfa was 1.76, 0.33, and 2.14 per cent, respectively, for the first crop and 2.45, 0.46, and 0.96 for the eighth crop. Within limits, these three elements replaced each other in the plant economy without reducing yields. This became much more apparent when percentages were calculated to milliequivalents. For any given harvest, the combined m.e. of Ca, Mg, and K tended toward a constant, that constant being around 175 for the first crop of alfalfa and around 187 for the eighth crop grown on these twenty soils.

The Release of Exchangeable and Nonexchangeable Potassium from Different Soils Upon Cropping

Robert F. Chandler, Jr., and Michael Pech, Cornell University Agricultural Experiment Station, Ithaca, N. Y.

Long-time studies at Wooster, Ohio, and elsewhere have shown that approximately thirty pounds of nonexchangeable potassium is being released annually to crops. A thirty-year continuous-cropping experiment at Ithaca, N. Y., has shown that sufficient potassium has been released from the nonexchangeable form to provide for an average corn yield of about thirty-five bushels annually, even though the only material added to the soil was lime.

In view of facts of this nature, it was deemed important to study the amount of nonexchangeable potassium that was released to crops by soils of different natures. Studies of ten different New York soils are under way and the data on four of them are now complete.

When soils are continuously cropped with Ladino clover, and when all essential nutrients except potassium are present in sufficient amounts, the following statements may be made:

1. The potassium content of the plants decreases with time until a level is reached, below which the plants cannot live. This value seems to be about 0.33 per cent potassium.

2. The yield of the clover seems to be closely associated with the potassium content of the plants. The appearance of potassium deficiency symptoms is directly related to the potassium content of the crops.

3. The exchangeable potassium content of the soil decreases rather rapidly during the early stages of the growing period and then becomes more or less constant. This constant value varies with each soil and is apparently an important characteristic of the soil as far as its potassium relationships are concerned.

4. The amount of potassium removed from the soil by the crop is greatly in excess of the amount of decrease in exchangeable potassium of the soil. This excess expressed in percentage of the decrease in exchangeable potassium varies from 100 to over 500 per cent, depending upon the nature of the soil.

Leaf Analysis in Estimating the Potassium, Magnesium, and Nitrogen Needs of Fruit Trees

Damon Boynton, J. C. Cain, and O. C. Compton, Cornell University Agricultural Experiment Station, Ithaca, N. Y.

The usefulness of leaf analysis in furnishing measures of potassium, magnesium, and nitrogen needs of fruit trees has been indicated in the work of a number of horticulturists in the United States and elsewhere. Studies with apple, prune, peach and cherry trees in New York indicate that the ranges of potassium and magnesium percentages (dry weight) in leaves and the correlation between certain minimum values and response are satisfactory for diagnostic and prognostic purposes. The range of total nitrogen to McIntosh apple leaves, in response to differential nitrogen fertilization, is somewhat smaller than for the other two nutrient elements but the correla-

(Continued on page 24)

IT MAY BE

By SAMUEL L. VEITCH

SERIOUS BUSINESS OF CONGRESS

No doubt you have read the news item regarding a woman in Boston, who asked a waitress if she could substitute another vegetable in place of one offered in the regular course. The waitress' reply was, "Don't you know there's a war going on?" Whereby the lady jumped up and slammed the dishes on the floor. She became annoyed by hearing this threadbare, shopworn expression used so many times these days, which, in most cases, is just an alibi. Well, the point trying to be made is Congress must have forgotten there is a "war going on," for they have closed up shop and recessed until November 14th. Looks like they even need a week after election before they can settle down to the serious business of the Nation.

WAR MANPOWER COMMISSION

You may be interested to know the War Manpower Commission has lifted all its manpower controls, in so far as veterans of this war are concerned. About one and one-half million veterans already released are immediately affected. Previously these veterans were exempt from manpower control for only 60 days after their discharge. While this makes a veteran eligible for a job without first clearing through the United States Employment Service, yet any veteran who seeks employment through the United States Employment Service will be entitled to referral, as a matter of right, to any job of his choice. The essentiality or priority status of such a job will not be a factor. The order also stipulates that veterans may be hired without regard to employment ceilings, which are restrictions on the size of labor forces a plant may employ. This ruling should be of interest and importance to employers as well as to veterans.

WAR SURPLUSES

It may be there will be a slacking off of sales on War Surplus Materials until the Government has an opportunity to adjust according to the new law. A three-man board for this branch is frowned upon by some. The feeling is the three-man board gives the opportunity to "pass the buck," whereas a one-man board always makes it possible to put the finger on the one making a mistake.

FOREIGN GOLD

It may be at the end of this year foreign Nations will have some twenty-two billions in gold and dollar balances on deposit in the United States. This does not include foreign-owned American securities and direct investments in American industry.

RECORDING DISCHARGES

A suggestion is offered that all ex-service men of this war and World War I have their honorable discharges recorded with their County Recorder. In addition, have a photostat copy made and then put the original away in a safe place, for example, a safe deposit box. It would be well for the wives, parents, and friends to make a note of this and remind their own particular service men or women to do this immediately upon his (or her) return before the discharge has any chance of being lost or mislaid.

LIBERATED BELGIUM

The progressive liberation of Belgium makes it important for American manufacturers to familiarize themselves with the future trade possibilities of that war-torn country. Until the outbreak of hostilities, the trade situation in Belgium regarding products bought and sold by the United States was as follows, listed according to importance:

Bought:

1. Precious stones
2. Cotton carpets
3. Linen, bleached
4. Malt
5. Commercial fertilizers

Sold:

1. Auto parts and accessories
2. Cotton, raw and Kapok
3. Wheat
4. Lubricating oil
5. Linseed oilcake

It is assumed the range of commodities required for the reconstruction of Belgium and for sustenance of her people will be greatly extended. All kinds of machinery and machine tools, agricultural equipment, textiles, foods, rubber products and many other items will be urgently needed. Please note! Belgium has approximately 750 million dollars in gold and foreign exchange available to start on her rehabilitation program.

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Vol. 101

OCTOBER 7, 1944

No. 7

Principal Articles in This Issue

THE NEED FOR BORAX ON FOURTEEN CROPS.....	7
THE AMERICAN CHEMICAL SOCIETY....	10
IT MAY BE.....	11
Post-War Recommendations by U. S. D. A. on Use of Nitrogen Plants.....	12
Farm Income at Peak.....	13
September Tax Tag Sales.....	14
FERTILIZER MATERIALS MARKET:	
New York.....	15
Baltimore.....	15
Charleston.....	17
Philadelphia.....	17
Chicago.....	18
Tennessee Phosphate.....	18
More Fertilizer Per Acre on Cotton....	20
International Issues Annual Report....	20

Post-War Recommendations by U. S. D. A. on Use of Nitrogen Plants

On September 12th, Secretary of Agriculture Claude R. Wickard made public the recommendations of a U. S. D. A. post-war planning group, calling for the production of solid nitrogen fertilizer at some of the synthetic ammonia plants now operated by the Government.

"These recommendations represent sound public policy," Secretary Wickard declared. "Their adoption would help to assure farmers enough nitrogen fertilizer to meet their demands at reasonable prices after the war, enable the people to realize beneficial peacetime results from the public money invested in chemical war plants, and in case of emergencies to provide nitrogen for explosives without jeopardizing the nation's food supplies."

Without recommending whether Government or private industry should operate the plants after the war, the post-war group in its report favors the ultimate conversion of nearly 40 per cent of the total rated nitrogen-producing capacity of existing Government plants for the production of granular nitrogen fertilizer, ammonia, and ammonia derivatives to meet post-war requirements of agriculture and industry. It also recommends that all other Government nitrogen-producing plants should be maintained in a stand-by condition as part of the military establishment. In this state they would be available to meet unanticipated demands for fixed nitrogen by agriculture or industry.

The group based its estimates of requirements on assumptions as to national and farm income, nitrogen fertilizer prices, and soil and crop needs. Under relatively unfavorable conditions, fertilizer nitrogen consumption is estimated at 500,000 tons (in terms of nitrogen); under favorable conditions, 750,000 tons; under the most favorable conditions, 900,000 tons.

Industrial consumption is expected to range between 175,000 and 300,000 tons nitrogen. In addition to certain synthetic production, substantial imports of natural Chilean nitrate of soda and of other nitrogenous fertilizer, will be necessary.

Secretary Wickard said that operation of some of the Government plants for fertilizer production would continue a practice that has developed during the war, under which surplus War Department ammonia has been diverted to the production of fertilizers, sub-

stantially increasing the supply of nitrogen fertilizer available for use on 1944 crops.

The group, pointing out an immediate demand for more granular nitrogen fertilizer, recommends that some of the Government ammonia plants be equipped to produce such fertilizers by modern methods. This would require substantial capital investment but would permit the production of improved granular fertilizer at costs lower than those now incurred in making granular nitrogen from surplus ammonia.

Installing this equipment now would not interfere with military use of the plants, the report states. On the other hand, this would permit the best use of surplus ammonia now and would be the first step in converting the plants to meet anticipated post-war demands.

The proposed conversion of about 40 per cent of the Government plants' capacity for production of civilian requirements would

Mathieson Opens New Ammonia Plant

Production of ammonia from a new plant at Lake Charles, La., is announced by George W. Dolan, president of the Mathieson Alkali Works (Inc.). The plant is one of the two largest in the country producing ammonia from natural gas.

Built by the Defense Plant Corporation and operated under lease by Mathieson, the new plant is fully engaged in war production, the ammonia being used to produce high explosives. After the war, the operation is expected to manufacture chemical fertilizers for Southern farmers and anhydrous ammonia for refrigeration.

The new plant is near to its sources of raw materials and has the advantage of low fuel costs as well as low shipping costs by water and rail throughout the Gulf States and the Mississippi Valley.

In addition to ammonia, Mathieson produces caustic soda, soda ash and synthetic salt cake at Lake Charles. Other manufacturing centers of the Mathieson organization are located at Niagara Falls, N. Y., and Saltville, Va. The Niagara Falls plant was a pioneer producer of synthetic ammonia in this country.

Farm Income at Peak

Cash income of American farmers, from marketings and Government payments, will be greater in 1944 than it has ever been in any previous year. Income in the twelve months ended with September was about 20½ billion dollars. This was a billion more than income in the year 1943. It was two and one-half times as large as income in 1938, the last pre-war year. It was five times as great as annual farm income at the bottom of the depression. It was double the farm income of 1929, the last pre-depression year. It was almost 50 per cent larger than 1919, which was the all-time peak in farm income until 1942.

Income received from marketings of all types of farm products has risen substantially, although the increases for some groups of products have been much larger than increases for others. The following tabulation shows the percentage increases in income from farm marketings, for the January-September period, from the 1938-1942 average to 1944.

	%
Cotton and cottonseed.....	49
Dairy products.....	74
Food grains.....	85
Feed grains and hay.....	94
Tobacco.....	98
Meat animals.....	122
Vegetables.....	122
Poultry and eggs.....	126
Fruits and nuts.....	154
Oil-bearing crops.....	190
All farm products.....	104

Manual for Handling and Storage of Chemicals in Paper Bags

To meet the need resulting from a substantial increase in the use of paper shipping sacks for the packaging of chemicals and allied products, the Manufacturing Chemists' Association has prepared a new six-page manual on recommended practice in the handling and storing of multiwall paper bags. These handling instructions provide a valuable guide for both shippers and consignees on the proper use of these containers. Written in language easily understood by the average workman, descriptive text is supplemented by fourteen illustrations, and deals with such specific operations as lifting, carrying and loading of bags on trucks; spot repairs; use of overslip bags; exposure to elements; handling equipment (hand and platform trucks, skids, pallets, conveyor systems);

unloading freight cars, auto trucks and vessels; storage; stacking; and methods of opening bags.

Manual Sheet B-1 is the thirty-first in a series of M. C. A. publications on standard and recommended practice. It was prepared with the cooperation of paper shipping sack manufacturers. Copies may be obtained from the M. C. A., 608 Woodward Building, Washington 5, D. C., at 15 cents each, with a 10 per cent discount on lots of ten or more.

September Tax Tag Sales

Fertilizer tax tag sales in September in the seventeen reporting States represented 370,000 tons, compared with 310,000 tons a year ago and 231,000 tons two years ago. Increases over last year were reported by eleven of the

seventeen States. The largest increase took place in Louisiana. Increases in four of the five Midwestern States more than offset in that region a decline in Indiana sales.

Demand for fertilizer for use this fall is probably greater than it has ever been before. Economic factors are favorable to increased fertilizer use. It is quite likely, however, that tag sales in September and in the remaining months of 1944 will reflect in part the early buying of tags for use in 1945.

Total tag sales in the first nine months of this year were a little larger than in the corresponding period of 1943, with a rise in the Midwest being large enough to offset a decline in the South. The comparatively small increase over last year is partially the result of the abnormally large sales in the last quarter of 1943, produced for use in 1944.

FERTILIZER TAX TAG SALES

STATE	SEPTEMBER				JANUARY-SEPTEMBER			
	1944 Tons	1943 Tons	1942 Tons	% 1943	1944 Tons	1943 Tons	1942 Tons	
Virginia.....	41,313	47,383	34,021	104	418,148	400,265	374,239	
North Carolina.....	24,526	39,076	29,677	96	1,089,719	1,133,561	1,076,264	
South Carolina.....	10,600	15,015	10,900	89	635,123	715,783	622,194	
Georgia.....	16,808	17,674	15,518	99	883,669	894,503	747,468	
Florida.....	70,540	48,234	41,880	119	637,834	538,205	453,138	
Alabama.....	14,450	8,650	3,950	91	571,850	631,700	559,700	
Mississippi.....	15,150	8,500	4,962	83	321,814	387,544	292,029	
Tennessee.....	10,439	12,700	9,563	112	229,519	205,353	159,743	
Arkansas.....	4,600	4,300	3,850	67	108,083	161,275	133,158	
Louisiana.....	66,200	33,500	7,550	112	200,920	178,688	142,986	
Texas.....	20,105	15,823	7,176	109	160,678	146,950	117,294	
Oklahoma.....	2,500	500	986	96	16,851	17,588	8,747	
Total South.....	297,231	251,355	170,033	97	5,274,208	5,411,415	4,686,960	
Indiana.....	17,459	22,460	34,171	88	333,547	379,990	385,104	
Illinois.....	15,350	7,349	6,418	166	139,890	84,093	78,196	
Kentucky.....	15,705	11,705	9,525	151	222,999	147,206	136,352	
Missouri.....	19,364	12,786	7,675	151	132,602	88,046	69,924	
Kansas.....	4,750	4,300	3,605	231	37,496	16,204	11,365	
Total Midwest.....	72,628	58,600	61,394	121	866,534	715,539	680,941	
Grand Total.....	369,859	309,955	231,427	100	6,140,742	6,126,954	5,367,901	

BRADLEY & BAKER

FERTILIZER MATERIALS - FEEDSTUFFS

AGENTS - IMPORTERS - BROKERS

155 E. 44th Street
NEW YORK

Clinton St. & Danville Ave.
Baltimore, Md.

BRANCHES
505 Royster Building
Norfolk, Va.

1252 West Beaver Street
Jacksonville, Fla.

504 Merchants' Exchange Bldg., St. Louis, Mo.

FERTILIZER MATERIALS MARKET

NEW YORK

Additional Allocations of Sulphate of Ammonia Possible. No Increase in Nitrate of Soda Prices. Labor and Sulphuric Acid Shortage Still Handicap Superphosphate Production.

Exclusive Correspondence to "The American Fertilizer"

NEW YORK, October 3, 1944.

Sulphate of Ammonia

Deliveries against allocations previously made has prevented any considerable stock accumulations. There is some indication that additional allocations of sulphate of ammonia might be made shortly and if such allocations are made, buyers will surely take up to the limit allowed.

Nitrate of Soda

Price for American nitrate of soda has been continued for shipment during October on the same basis as September deliveries.

Superphosphate

Continued labor difficulties, along with insufficient supply of sulphuric acid, are not helping the larger production of superphosphate requested by the Washington program. The market is firm with full ceiling prices being obtained in all sections.

Potash

Production continues as expected but no stock piles are accumulating as the expected production has been fully allocated and buyers are taking material in line with contracts already made which covered the allocations given. Some re-allocations were necessary but no surplus was left over.

Phosphate Rock

Shipments are continuing and the supplies will probably be ample to take care of demands of acidulators.

More Chilean Nitrate Promised

It is reported that the Chilean Nitrate Sales Corporation has agreed to import 850,000 tons of Chilean nitrate of soda for agricultural use during the 1944-1945 season. This is 200,000 tons more than was imported for the 1943-1944 season.

BALTIMORE

Shortage of Chemical Ammonia Expected by Spring. Efforts Being Made to Increase Imports of Nitrate of Soda. Potash Supply Adequate.

Exclusive Correspondence to "The American Fertilizer"

BALTIMORE, October 3, 1944.

There is nothing new to report in the fertilizer situation during the past two weeks. Labor continues scarce, and unless there is an easing up in this situation this may be an important factor in the tonnage program for next spring.

Ammoniates.—The market on both tankage and blood continues well sold up for feeding purposes, and the prevailing market on mixed goods does not encourage the use of organic ammoniates on account of the high cost due to feeding demand competition.

Castor Pomace.—Producers continue well sold up and are not taking on any new business.

Fish Scrap.—Due to unfavorable weather conditions the catch during the past two weeks has been very light, and it is now doubtful whether producers will be able to complete contracts made on "subject to catch" basis.

Sulphate of Ammonia.—Manufacturers are still taking deliveries against allocations of this material as well as liquid ammonia, but in some quarters it is anticipated there may be an ammonia shortage by the time next spring season rolls around.

Nitrate of Soda.—A great deal will depend upon the tonnage of Chilean imported into this country by the Government. Efforts are being made to have an increased tonnage brought in during the coming season to offset possibility of ammonia shortage. In the meantime the market remains unchanged at previously established levels.

Superphosphate.—The situation remains unchanged, but manufacturers are endeavoring



HEROES OF WORLD WAR II

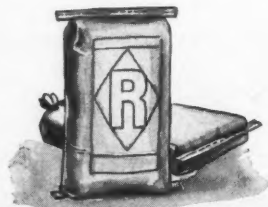
The VICTORY GARDENERS—Men, women and children. They, rich and poor alike, produced more than 50% of our food supply in 1944. According to a Government report more than 20 million victory gardens were cultivated in 1944. **FOOD WINS WARS.**

A gold award to fertilizer producers, packers and shippers

Without the cooperation of the entire fertilizer industry the outstanding success of millions of victory gardeners would have been impossible.

We are proud of the fact that a great portion of the fertilizer used in victory gardens was packed and shipped in **RAYMOND MULTI-WALL PAPER SHIPPING SACKS.**

You can identify a Raymond Sack by its bright, attractive printing.



THE RAYMOND BAG COMPANY
MIDDLETOWN, OHIO.

to take care of their regular customers in spite of the scarcity of sulphuric acid and the labor shortage. While price of 65 cents per unit of A. P. A. in bulk, f. o. b. producers' works, is merely nominal, it is impossible to place any orders outside of established trade channels.

Potash.—Deliveries are being made against current contracts and fertilizer manufacturers are storing supplies to take care of the coming spring season's business.

Bone Meal.—Raw and steamed bone meal continue scarce and domestic supplies are not being augmented by any important importations of the South American product.

Bags.—Burlap is still under Government control and while all indications point to a tight situation, it is anticipated there will be sufficient burlap available to take care of requirements of fertilizer manufacturers whose demands, however, will be only a fraction of normal due to the comparative high cost prevailing on burlap and much lower market on paper containers.

CHARLESTON

Movement of Fertilizers to Farmers Slower Than Last Year. Ammonia Solutions Allocation Cut. Organics Scarce.

Exclusive Correspondence to "The American Fertilizer"

CHARLESTON, October 3, 1944.

The movement so far of fertilizers to the farmers has not been up to the pitch that it was this time last season.

Organics.—These continue scarce with practically no offerings of nitrogenous tankage, castor pomace, hoof meal, etc.

Ammonium Nitrate.—The discounts have now been eliminated on this material and the market is at the base price of \$50.00 per ton in 100-pound bags at shipping points.

Ammonia Solutions.—The report has been that solutions recently have only been cut

25 per cent from the fertilizer manufacturers' requests, but quite a number of the manufacturers state that their recent requests have not been granted as fully as this.

Sulphate of Ammonia.—The demand for this is so strong that it is stopping any accumulations.

Nitrate of Soda.—The September price for Arcadian nitrate of soda has been extended through October.

PHILADELPHIA

Short Labor Supply and Inadequate Sulphuric Acid Affecting Superphosphate Production. Organics Somewhat More Plentiful.

Exclusive Correspondence to "The American Fertilizer"

PHILADELPHIA, October 3, 1944.

The labor situation and the short supply of sulphuric acid dominated the news during the past couple of weeks. While not much can be done about the shortage of labor, efforts are being made to increase the sulphuric acid supply. Let us hope it is.

The two foregoing conditions have had an effect upon the supply of superphosphate, and this commodity is not any too plentiful.

Ammoniates.—The organic materials seem to be more plentiful, although producers' ideas are still at the ceilings, and buyers have somewhat different thoughts on that. The inorganic nitrogen items move in a routine way under the regulations.

Sulphate of Ammonia.—Supply is reported good, and the demand continues steady.

Nitrate of Soda.—Price to remain the same for October, as for previous months.

Superphosphate.—Very firm, and the supply in some areas not quite sufficient for the demand.

Bone Meal.—Supply a little more plentiful, but demand continues good, particularly for raw.

Manufacturers'
Sales Agents

for **DOMESTIC**

Sulphate of Ammonia

Ammonia Liquor

::

Anhydrous Ammonia

HYDROCARBON PRODUCTS CO., INC.

500 Fifth Avenue, New York

Potashes.—Production maintains a high rate, and holds its own with the demand.

Castor Pomace.—Extremely scarce, and the limited supply goes only to old customers.

CHICAGO

Demand for Fertilizer Organics at Ceiling Prices Continues but Supplies Limited. Feed Market Quiet.

Exclusive Correspondence to "The American Fertilizer"

CHICAGO, October 2, 1944.

Buying interest in organics at full ceiling prices continues apace, but offerings from sellers are exceedingly limited. Manufacturers are urging shipments earlier than usual on contracts previously made, and that may be another cause for sellers' hesitancy making new sales at this time.

In feeds it appears that buyers are adopting a cautious program, though no selling pressure is evident, all ceiling prices being fairly well maintained.

Ceiling prices are:

High grade ground fertilizer tankage, \$3.85 to \$4.00 (\$4.68 to \$4.86 per unit N) and 10 cents; standard grades crushed feeding tankage, \$5.53 per unit ammonia (\$6.72 per unit N); blood, \$5.53 (\$6.72 per unit N); dry rendered tankage, \$1.25 per unit of protein, f. o. b. producing points.

TENNESSEE PHOSPHATE

Floods Hamper Harvesting and Rock Mining. Curtis Urges Conservation of Tennessee Phosphate. Discusses Western Deposits.

Exclusive Correspondence to "The American Fertilizer"

COLUMBIA, TENN., October 2, 1944.

Several severe floods have accompanied rather too plentiful rains causing some damage but not as much as in the first week of September. This has seriously interfered with fall tobacco harvest and curing, with some

slowing up of outside phosphate mining.

Normal shipment has continued to the comparatively small blast furnace lump rock trade, which could, of course, be very active and still cut no figure in tonnage shipped and consumed. The activity in other lines, forming the main consuming channels of large-scale production, together with the decreasing supply of lump suitable for blast furnace use, makes producers loath to sell direct to that trade, as it interferes with other production.

Consumers of ground rock for direct application are despairing of getting anything like the tonnage desired by farmers for the present most desirable season for application, as well as for earning the benefit payments allowed in the states where this use of phosphate rock is most in vogue.

The Middle Tennessee Technical Society at its September 26th meeting had as its guest speaker Dr. H. A. Curtis, formerly Chief Chemical Engineer of TVA, now a general consultant for TVA and in the Chemical Engineering Department of the University of Missouri. His subject was the "Western Phosphate Deposits and Their Prospective Development," of which he has been making a close study for some time. His line of thought seemed to run that there was no large surplus water power near enough to the deposits to permit electric furnace development such as in Tennessee, limiting production of treble super to wet process, with possibility of one blast furnace layout, which he stated was not yet far enough past the uncertainties in recoveries which handicap that process in comparison with electric furnaces to give any dependence on it being possible to supply Midwestern regions and certainly not Eastern and Southeastern. He intimated that it was therefore most important for Tennessee to conserve her limited supply of rock in the ground for future gen-



Trade Mark Registered

MAGNESIUM LIMESTONE

"It's a Dolomite"

American Limestone Company

Knoxville, Tenn.

To keep you supplied with Bags

WE'RE NOT OVERLOOKING
A SINGLE BET

THERE are many angles to the job of keeping the fertilizer industry supplied with bags in these days of shortages. But we're working on all of them! Here's an example:

A shortage of the necessary cotton cloth is, of course, a bottleneck. So, to supplement our usual close cooperation with the cotton industry, we took an unusual step —

An advertisement, appearing in the leading cotton textile newspaper, told the cotton merchants (1) about the amazing growth of the essential fertilizer industry, (2) the need for bags for fertilizer and (3) the types of cotton goods particularly needed.

The whole object of this unusual undertaking is to create a closer cooperation between the cotton textile and the bag industries . . . to give you greater assurance of the supply of bags you need.

BEMIS BRO. BAG CO.

Baltimore • Boston • Brooklyn • Buffalo • Charlotte
Chicago • Denver • Detroit • East Pepperell • Houston
Indianapolis • Kansas City • Los Angeles • Louisville
Memphis • Minneapolis • Mobile • New Orleans • New
York City • Norfolk • Oklahoma City • Omaha • Peoria
St. Helens, Ore. • St. Louis • Salina • Salt Lake City
San Francisco • Seattle • Wichita • Wilmington, Calif.

No. 10 . . . of a Series . . .

An Open Letter to the Cotton Textile Industry:

☆ ☆ ☆

One of the largest, and fastest-growing uses for bags is shipping commercial fertilizer. The cotton constructions used in making these bags are principally 36" x 93" yd and 40" x 111" yd. Omaha.

A quick review of the growth of the business and the trend in its use of bags may be interesting.

In the 1920's, the annual consumption of commercial fertilizer in the United States ranged from 6 to 8 million tons. In 1932, when farm prices were depressed, it rose to about 4 million tons, after which it started a rather rapid climb. Last year the total was over 11 million tons. It will probably exceed that mark this year.

As for the importance of the fertilizer industry, consider this: 30% of United States crop production last year was due to the use of fertilizer. Putting it another way—without the help of fertilizer, cultivation of an additional 30 million acres would have been necessary in order to produce the same volume of farm crops. And 30 million acres is nearly one and one-half times the area of the State of Iowa.

Now for a little bag history. Up to about 1918, fertilizer was packed principally in barrels. Cottons accounted for only about 15% and paper about 1%.

In the intervening years, burlap held fairly steady in the actual number of bags used, although it declined percentage-wise because total fertilizer production had gone up. Another factor—during part of 1942 and all of 1943, the use of burlap bags for fertilizer was prohibited by the WPB.

Since 1934, cotton bags definitely have gained in preference. In 1943 more than three times as many were used as in 1942, accounting for about 27% of the total.

Here's an interesting observation from the cotton viewpoint. Last year, the first full year when burlap was not permitted to be used for fertilizer, a choice between cotton and paper bags had to be made to replace the prohibited burlap.

Since delivery of cotton bags increased over the previous year, much more than three times as many of paper, the preference must have been for cotton.

Burlap is coming back into the picture to some extent as WPB now permits it to be used. However, if cotton goods can be provided in sufficient quantity to meet the continually increasing demand for cotton bags, there is a good chance that the important volume of business can be retained after the war even when other types of bags are again freely available.



Bemis Bro. Bag Co.

TERMINAL BAG PLANTS at . . . Brooklyn • Buffalo • Houston • Indianapolis • Kansas City • Memphis • Minneapolis • New Orleans • Omaha • St. Louis • San Francisco • Seattle • Wichita

This is a greatly reduced reproduction of the advertisement to the cotton textile industry, telling how cotton goods are required for bags for fertilizer. Copy will be sent you on request.



East Pepperell, Mass.

erations so as to increase the life expectation of the industry here.

Work on the new TVA plant at Godwin for production of fused phosphate rock to have a content of $27\frac{1}{2}$ per cent P_2O_5 and only about 0.3 per cent fluorine, has progressed with rapidity. On account of some difficulties in securing critical materials and equipment, it is not now expected to be in production before January 1, 1945, and as yet no announcement has been made as to how the product will be sold or at what price. The project estimate of cost on a 40,000-ton base, with phosphate rock cost at \$4.00 per ton, was \$40.00 per ton, so that with any mark-up at all for freight, handling and distribution it would not appear likely to be very competitive with bone meal at ordinary levels, but will likely be of considerable interest under present conditions. However, not many private producers of ground phosphate rock would be tempted to make this investment in order to have to sell this product at above \$40.00 per net ton in order to get \$4.00 per gross ton for their rock.

More Fertilizer Per Acre on Cotton

In the period from 1925 through 1930 there was used on cotton acreage in this country an average of 2,100,000 tons of commercial fertilizer each year. Of every 100 tons of fertilizer used in those years, twenty-eight tons were used on cotton. This year, 1,547,000 tons of fertilizer were used on cotton. This was equivalent to only twelve of every 100 tons of fertilizer used on all crops.

While the tonnage of fertilizer used on cotton has fallen off by one-fourth, however, cotton acreage has declined by more than one-half. The much greater decline in acreage than in fertilizer tonnage indicates that the acreage now planted to cotton is fertilized more heavily than was formerly the practice. The proportion of total cotton acreage fertilized and the rate of application, have both risen sharply above the pre-depression levels.

If the 1944 cotton acreage had received fertilizer at the same rate as in 1925-1930, the tonnage used would have been 977,000 tons instead of 1,547,000 tons. Thus the increases in the percentage of acreage fertilized and rate of application resulted in the additional use of 570,000 tons of fertilizer.

In contrast to the decline of one-fourth in the tonnage of fertilizer used on cotton from

1925-1930 to 1944, the tonnage used on crops other than cotton increased by 90 per cent in that period. The increase has been particularly marked in the tonnage used on vegetables, fruits, and grasslands.

Farm Machinery Rationing Ends

Judge Marvin Jones, War Food Administrator, has ended all WFA rationing and distribution control of farm machinery and equipment, except corn pickers. This action, Judge Jones stated, is in line with the WFA policy of constantly examining all of its wartime regulations and removing them as soon as they are no longer essential. For most rationed implements, U.S.D.A. said, the 1944 production period and season of use have passed, and the need for rationing these items during the 1944-45 crop year is not anticipated.

International Issues Annual Report

International Minerals & Chemical Corporation had net profit, after extraordinary items, of \$2,016,037 for the fiscal year ended June 30, 1944, as compared with a net profit of \$2,081,738 for the previous fiscal year, according to the annual report to stockholders of the corporation released on September 12th.

In a letter to stockholders accompanying the report, Louis Ware, president of the corporation, pointed out that "net operating profit before extraordinary items and income taxes showed an increase of \$297,639. Earnings on the common stock outstanding at June 30, 1944, amounted to \$3.11 per share this year as compared with \$3.23 last year."

Net profit before provision for income taxes and extraordinary items amounted to \$3,139,679 for the year ended June 30, 1944, which compares with \$2,842,040 and \$2,604,343 for

STEDMAN FERTILIZER PLANT EQUIPMENT

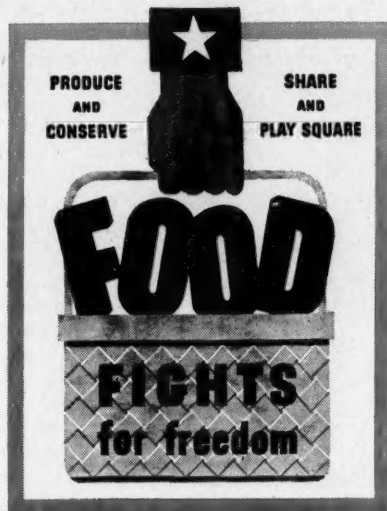
Dependable for more than 50 Years

All-Steel
Self-Contained
Fertilizer
Mixing Units
Batch Mixers—
Dry Batching

Pan Mixers—
Wet Mixing
Swing Hammer
and Cage Type
Tailings
Pulverizers

Vibrating
Screens
Dust Weigh
Hoppers
Acid Weigh
Scales

STEDMAN'S FOUNDRY & MACHINE WORKS
AUBURN, INDIANA, U.S.A. Founded 1934



International **CROP-PRODUCING FERTILIZER MATERIALS**

Will help you make the quality fertilizers which farmers need to do their job of producing more food for victory.

MINERALS
CHEMICALS

International **MINERALS & CHEMICAL CORPORATION**

General Offices • 20 North Wacker Drive • Chicago

Florida Pebble Phosphate Rock
68%—70%—72%—75%—77%

Tennessee Phosphate Rock
66%—68%—72%

Superphosphate
Multiple Superphosphate

Domestic Potash Salts

All Standard Grades of Potash
Including SUL-PO-MAG

(Sulphate of Potash-Magnesia)

Complete Fertilizers

PHOSPHATE • POTASH • FERTILIZER • CHEMICALS

the years ended June 30, 1943, and June 30, 1942, respectively.

The consolidated statement of income contained in the report shows net sales of \$27,348,667 for the fiscal year ended June 30, 1944, which compares with \$22,477,375 for the similar period ended June 30, 1943, and \$18,122,891 for the year ended June 30, 1942.

Continuing in his letter to shareholders, Mr. Ware said:

"During the year, all of the operations and plants were producing at capacity. The volume of goods produced and sales were greater than any year in the Corporation's history. The output of our mines, fertilizer factories and chemical plants contributed measurably to the great production needed by our country in this year of war.

"Definite progress was made in further expansion of our business, development of new products that afford increased diversification and the improvement of the Corporation's facilities. Dividends were paid, the funded debt was further reduced, new additions were made to the plants and working capital was increased.

"Provision for federal and state income taxes amounted to \$680,000 as compared with \$1,300,000 last year. The Revenue Act of 1943 provides for percentage depletion at the rate of 15 per cent of potash sales limited to 50 per cent of the net profit from the potash operations. This allowance became effective January 1, 1944.

"The sale of phosphate ore lands resulting in a loss of \$443,642 was in line with the Corporation policy of disposing of assets not required in the Corporation's business."

The balance sheet shows net current assets of \$8,633,832 whereas last year they were \$6,600,522, or an increase of \$2,033,310. The ratio of current assets to current liabilities at June 30, 1944, was 7.62 compared with 4.05 last year.

Cash dividend payments during the year amounted to \$894,239, of which \$394,920 was paid to the preferred stockholders at the rate of \$4.00 per share and \$499,319, or \$1.00 per share, to the holders of common stock.

"At the Government's request the Corporation has filed schedules of its sales of goods which may eventually be used in Government war purchases with the Reconstruction Finance Corporation, Price Adjustment Board. Most of the Corporation's products are not subject to renegotiation. Fees received for the construction, operation and management of the magnesium plant built for the Government and costing in excess of \$18,800,000

totaled only \$463,324 during the past three years.

"The Fertilizer Division has completed its best year in both tonnage and profit. The increase in tonnage shipped was 13 per cent over the previous year.

"Shipments from the Florida phosphate mines were the largest of any year in the Corporation's history and earnings were substantially greater than last year. The Peace Valley Mine continued its excellent performance and additional facilities installed during the year contributed to new records of cost, efficiency and output.

"Inquiry for foreign shipment began again to appear, and prompt resumption of exports after cessation of hostilities in Europe is expected to offset any temporary slackening of domestic demand.

"Sales of the Potash Division were 30 per cent above last year. Improvement in recoveries and volume have resulted from expenditures for plant improvements. During the year, approximately \$345,000 was expended on additions to the mine and refinery.

"The Magnesium Division produced metal at the 24,000,000 pound annual rated capacity of the plant. Ninety per cent of the metal produced was alloyed for use in airplanes and incendiary bombs. The magnesium plant, owned by the Defense Plant Corporation, is

Mineralize with Es-Min-El!

For quality fruits and vegetables feed your
soil minerals . . . the essential mineral
elements found in Es-Min-El.

The Mark of Quality

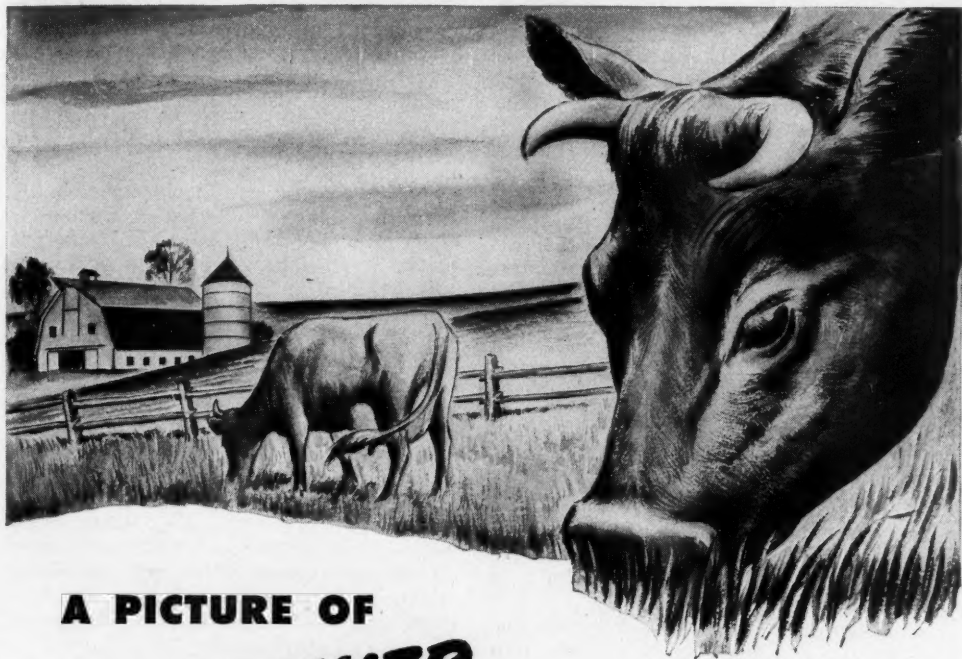


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For
Free Bulletins

TENNESSEE CORPORATION

ATLANTA, GEORGIA

LOCKLAND, OHIO



A PICTURE OF **COW POWER** SAVING MAN POWER



USING NITROGEN liberally on pastures not only boosts the tonnage and increases the protein content of the grass produced. It even points a way to help relieve shortages of man-power your customers may experience next Spring.

For, pasture-feeding of grazing animals can save labor and equipment for other tasks and bring "cow-power" to the rescue of man-power.

When you think of nitrogen for pastures, remember that Du Pont Urea-Ammonia

Liquor and "Uramon" fertilizer compound can help supply some of the large quantity of nitrogen that grass demands. Fullest benefits are obtained from nitrogen when adequate amounts of phosphoric acid and potash are available. E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Delaware.

DU PONT "URAMON"
REG. U. S. PAT. OFF.
FERTILIZER COMPOUND

**UREA-AMMONIA
LIQUOR**



BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

operated by the Corporation for a nominal management fee.

"The Corporation is continuing to give greater attention to research. Attention is also being given to the development of new products, which will further add to the diversification of the Corporation's activities.

"The Corporation has enjoyed a successful year. During the coming year, even with the likelihood of an early lessening or termination of part of the country's enormous war demands, it is believed requirements for the phosphate, potash, fertilizer and chemicals which we produce will continue at a high rate," Mr. Ware concluded.

THE AMERICAN CHEMICAL SOCIETY

(Continued from page 10)

tion between leaf nitrogen and response seems satisfactory.

Interpretation of leaf analysis for these constituents must take into account possible external injuries to the roots, trunks, or leaves of the trees sampled, the age of the leaves sampled, possible seasonal and climatic influences, as well as interrelationships between potassium and magnesium, and between nitrogen and potassium. If leaf analysis are interpreted in the light of these influencing factors, and are coupled with careful observations on tree behavior, they may be of considerable value to the diagnostician.

Thermal Defluorination of Superphosphate

E. J. Fox, D. S. Reynolds, K. D. Jacob, and W. L. Hill, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture, Beltsville, Md.

A laboratory study was made of the thermal defluorination of ordinary superphosphate with special reference to the preparation of a low-fluorine, phosphorus supplement for livestock.

With small charges heated in a current of air, 80 per cent of the fluorine was volatilized in fifteen minutes at 500° C. and 97 to 99 per

cent at 700° to 1,000° C. Little or no increase in volatilization of fluorine was obtained by heating for longer periods. In the temperature range 500° to 800° C. and with a heating period of thirty minutes the phosphorus in the product was only 30 to 45 per cent soluble in 0.4 per cent hydrochloric acid (1-gram sample digested with 100 cc. of acid for one hour at room temperature with shaking at five-minute intervals), compared to 95 per cent solubility of the phosphorus in the original superphosphate. With higher temperatures the solubility of the phosphorus progressively increased to 85 per cent or more at 1,000° C. In general, the solubility of the phosphorus decreased with increase in the time of heating at 500° to 800° C., while the reverse was true at higher temperatures. Reaction between the calcium phosphate and the calcium sulphate of the superphosphate, accompanied by volatilization of sulphur compounds, commenced at about 600° C. and increased progressively with increase in temperature. With temperatures above 800° C. the solubility of the phosphorus in hydrochloric acid was directly related to the volatilization of sulphur.

Chemical analyses and x-ray diffraction examinations indicated that β -Ca(PO₃)₂, β -Ca₂P₂O₇, and β -Ca₃(PO₄)₂ are the principal phosphates in products of heating at 500° to 600°, 650° to 750°, and 1,000° to 1,100° C., respectively.

By heating superphosphate for four hours at 250° to 275° C. in an atmosphere of water vapor it was possible to volatilize 95 per cent of the fluorine and obtain a product in which the phosphorus was 85 per cent soluble in hydrochloric acid. With a temperature of 300° C. volatilization of the fluorine was more rapid, but the solubility of the phosphorus was considerably reduced. The nature of the soluble phosphate produced at 250° to 275° C. has not been determined.

(Continued on page 26)

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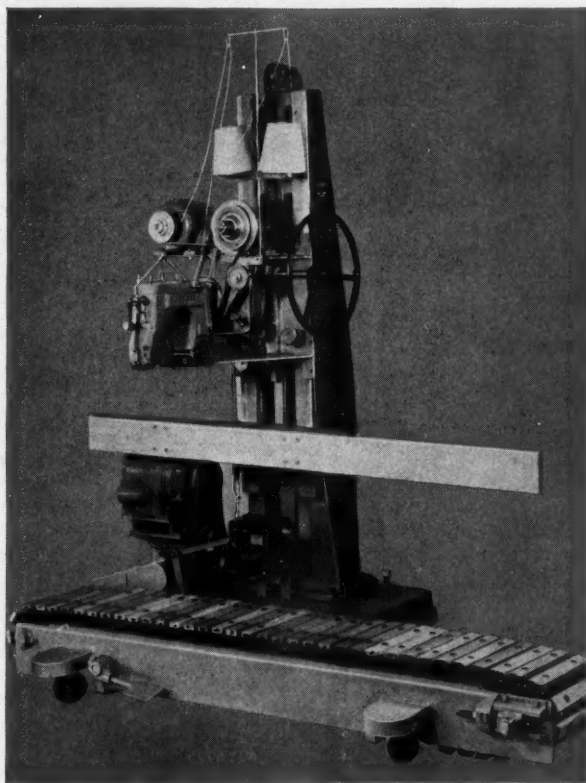
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The Preparation of a "Standard" Tricalcium Phosphate and Its Chemical Identification

W. H. MacIntire, George Palmer, and H. L. Marshall, University of Tennessee Agricultural Experiment Station, Knoxville, Tenn.

The decided variance in the chemical, structural, and fertilizer properties of commercial precipitated tricalcium phosphate prompted a process by which a precipitate of concordant composition and uniform properties can be prepared as a standard for chemical and biochemical researches. The process prescribes the dissolution of burnt lime in a concentrated sucrose solution, clarification, neutralization by the slow addition of concentrated H_3PO_4 , maintenance of low temperature, and vigorous agitation during reaction and thereafter.

Reproducibility of product was demonstrated by the uniformity of precipitates prepared by five operators. Heated at $900^\circ C.$, all of those precipitates yielded patterns of beta- $Ca_3(PO_4)_2$, whereas patterns of oxyphosphate were obtained by like ignitions of hydroxyapatites. The dissolvability of the product and that of its beta derivative in both ammonium citrate and 2 per cent citric acid serves to identify the tricalcium phosphate hydrate and differentiates it from hydroxyapatite. The process is proposed as one by which a standard tricalcium phosphate hydrate can be prepared in the laboratory and in batch operations.

Some Checks on Methods and Solutions Used in Analysis of Fertilizers

H. R. Allen, Kentucky Agricultural Experiment Station

A need for more checks on routine fertilizer analyses is shown by a study of the results of the check fertilizer analyses on samples prepared by Dr. E. W. Magruder. A comparison of the averages of the 5 lowest results and of the 5 highest results for nitrogen, available phosphoric acid, and potash for some of these samples shows variations which are too large. It is believed that the small particle size and the care with which these samples were prepared preclude the possibility that much of the variation is due to differences in the individual portions.

Procedures for checking the nitrogen, phosphoric acid, and potash determinations, using pure salts and the Bureau of Standards rock phosphate sample as standards are given and causes of some variations in results are pointed out. Preparation of the neutral ammonium citrate solution at other than the official temperature of 20° and determination of the ammonia to citric acid ratio of this solution by analysis are discussed.

A Study of Some Factors Affecting the Determination of Potash in Fertilizers

H. L. Mitchell and O. W. Ford, Department of Agricultural Chemistry, Purdue University Agricultural Experiment Station

In potash determinations by the Lindo-Gladding method values were obtained which show that the presence of phosphate causes low results. A colorimetric method was used for determining small amounts of potash in the material used as a phosphate source.

The colorimetric method indicates that corrections formerly made for potash in the phosphate source were too small. This error in previous work was probably due to losses through ignition, through solubility of K_2PtCl_6 in 80 per cent ethanol, etc., thereby failing to take into account all of the potash added with the phosphate. This in turn permitted high recovery values.

A study was conducted on the effect of residue formation on the potash values of a series of fertilizers. Failure to correct for the presence of residue by washing out the K_2PtCl_6 precipitate from the crucibles and reweighing yielded results ranging from 0.1 to 0.26 per cent higher than results obtained by washing out and reweighing. The amount of residue formed was partially dependent upon the amount of sodium hydroxide used in the determination.

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See Page 4



THE NEED FOR BORAX ON FOURTEEN CROPS

(Continued from page 9)

prominent than usual. Thus the yellow streaking, due to boron deficiency, was parallel to the leaf veinings. These streaking symptoms were noticeable only on close inspection, but they were better than yellowing alone as a basis for diagnosis of boron deficiency of red clover in farm fields. With borax, both the yellowing and streaking were fully corrected. The possibility that less severe boron deficiency of red clover may cause a "yellow top" condition similar to deficient alfalfa is not excluded, but in this instance all of the plant leaves were affected with "yellows." This deficiency was also more severe than that commonly reported to be responsible for lack of red clover seed.

Ladino Clover

Ladino likewise responded markedly to borax. Without it, the symptoms were much like red clover, the characteristic yellowing was observed, and normal leaf markings were obscured. Practically all leaves were affected. The deficiency was too severe for just the top leaves to be colored. Veinal and interveinal yellow streaking of a few leaves was also observed, similar to that noted with red clover, the rest of the leaf being a normal green color. Borax fully corrected these different types of leaf yellowing. Here again a "yellow top" condition was not obtained, but it seems likely that the right degree of deficiency may produce it.

Careful inspection would be required to detect signs of boron deficiency in fields of ladino and red clovers since there are other causes for legume leaves becoming a lemon yellow color. Only the interveinal and veinal yellowing would seem to serve well for diagnosis of this deficiency.

Timothy

This crop was in its first year from seeding and showed little, if any, response to borax. It was less affected by boron deficiency than any other crop grown in these experiments. However, since it is a long-

lived perennial, it may later show some deficiency.

Sweet Corn (Var. Golden Bantam)

Sweet corn responded very markedly to borax. Without it, prominent symptoms were observed. Longitudinal streaks of yellow tissue in the leaves were the first and most obvious. The streaks first appeared to be water-soaked, then they bleached and died. From a distance, the symptom looked somewhat like magnesium-deficiency, but on close inspection, the streaks were not continuous nor did they have regular edges. They appeared much more crudely fashioned than magnesium deficiency streaks. Chlorophyll was completely missing in them. Similar results of boron deficiency are also mentioned by Chandler in Maine, but he did not describe them.

Deficient leaf tips tended to die and turn brown. Sometimes also the dead leaf tips coiled in a longitudinal direction into a tube the diameter of a lead pencil. The new leaves were usually first affected. The tassel in these experiments failed to form. The ear grew but produced no silk and therefore no grain, although it had husks in normal fashion. Severe deficiency symptoms thus include leaf streaks, coiled leaf tips, lack of tassel, and lack of silk and grain. With borax, normal plants developed.

Tomatoes (Var. Marglobe)

Tomatoes responded markedly to boron. Without borax, the transplants remained about as tall as when set. New growth started feebly, became dirty green or pale yellow, and died. Plants changed from a healthy green to a dirty pale green, the stalks increasing somewhat in diameter but not in length. No fruit or blossoms were produced, although the dwarf plants hung onto life most of the summer before they died.

With borax, the plants were normal, flowered, and set a prolific crop of fruit. Boron deficiency was thus clearly responsible for lack of tomato flowers and fruit. Other signs of deficiency important to the grower, such as susceptibility to disease, probably remain to be produced.

(Continued on page 30)

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A United States War message prepared by the War Advertising Council; approved by the Office of War Information; and contributed by this magazine in cooperation with the Magazine Publishers of America.

Cabbage (Var. Golden Acre)

Cabbage likewise responded markedly to borax. Without it the transplants became a stump with only a few rudimentary outside leaves having brown edges. These brown edges had a rotten appearance and the cabbage failed to head. The inner leaves which tried to grow became crude stumps of leaf petioles with dead brown edges. The growing tip became brown, rotten, and completely failed to develop. Eventually the deficient transplants died without making any appreciable growth. With borax, good heads of cabbage were formed in normal fashion. These deficiency symptoms were more severe than the internal discoloration of the cabbage head usually reported.

Broccoli

A marked response to borax was obtained with broccoli. Without it there was almost a complete lack of edible buds. Eventually the plant grew an excessive amount of leaves and finally succeeded in producing some flower stalks. However, these were abortive and no seed formed, merely naked pedicels where the seed pods should have been. No yellowing was noted although the possibility of it should not be excluded.

With borax, the growth was vigorous, flower stalks formed early without any excessive leafy growth. A good supply of edible buds was produced, and these later developed considerable seed. With borax, the broccoli grew in the normal fashion. Cauliflower shows similar field response in Scotland.

Oats

Oats responded to boron in these experiments only in terms of the yield and quality of grain. Without borax, 14 gms. of light weight grain per pot were obtained; with borax, 35 gms. of heavy grain. Borax-treated oats were almost twice as heavy per unit of volume and germinated 93 per cent compared with 51 per cent without borax. Borax seemed to have no appreciable effect on the size, color, or vigor of these oat plants until the grain came to approximately the milk stage. The deficient grain withered and

aborted, while that receiving borax was well filled.

Similar observations in replicated field plots have been made once before by the writers. All evidence accumulated to date seems to show that empty heading of oats, which sometimes occurs in Vermont fields, is due in part at least to lack of boron in the fertilizer.

Lettuce (Var. Hansen)

Lettuce also responded markedly to borax. Without it, the seedlings grew about two inches high, became the characteristic yellow, or pale green, and died. No seed was produced. With borax, normal plants developed, headed in the normal fashion, flowered, and then set a good crop of seed. Borax clearly was necessary for formation of flowers and seed. Further efforts will be required to obtain symptoms of lesser deficiency arresting growth midway between the death of seedlings and flowering. Milder symptoms would be more apt to occur in ordinary gardens and appear to be causing some losses to Vermont growers.

Beets (Var. Detroit Dark Red)

Beets responded markedly to borax. Without it, the seedlings grew straw colored and died when less than two inches high. Death of seedlings was again the deficiency symptom obtained. With borax, plants were normal. This deficiency was much more severe than that which produces the scabby cankers and heart rot of the root commonly described in literature.

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- (4) Dunklee, D. E., and Midgley, A. R., "Need and Use of Boron for Alfalfa," Vermont Station *Bulletin* 501 (1943).
- (5) Heinrich, W., *Abst. in Deut. Landw. Presse*, p. 192, April 17, 1937. (Also abstracted by Dennis.)
- (6) Midgley, A. R., "Fifty-fifth Annual Report," Vermont Station *Bulletin* 495, p. 19 (1942).

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Tennessee Corporation, Atlanta, Ga.

Alphabetical List of Advertisers

American Agricultural Chemical Co., New York City.	3
American Limestone Co., Knoxville, Tenn.	18
American Potash and Chemical Corp., New York City.	4, 27
Armour Fertilizer Works, Atlanta, Ga.	5
Ashcraft-Wilkinson Co., Atlanta, Ga.	Front Cover
Bagpak, Inc., New York City.	25
Barrett Division, Allied Chemical & Dye Corporation, New York City.	—
Bemis Bro. Bag Co., St. Louis, Mo.	19
Bradley & Baker, New York City.	14
Chemical Construction Corp., New York City.	—
Chilean Nitrate Educational Bureau, New York City.	34
Du Pont de Nemours & Co., E. I., Wilmington, Del.	23
Farmers Fertilizer Co., Columbus, Ohio.	34
Fulton Bag & Cotton Mills, Atlanta, Ga.	6
Gascoyne & Co., Inc., Baltimore, Md.	34
Hayward Company, The, New York City.	34
Huber Co., L. W., New York City.	26
Hydrocarbon Products Co., New York City.	17
International Minerals & Chemical Corporation, Chicago, Ill.	21
Keim, Samuel D., Philadelphia, Pa.	33
McIver & Son, Alex. M., Charleston, S. C.	30
Monarch Mfg. Works, Inc., Philadelphia, Pa.	34
Nitrogen Products, Inc., New York City.	28
Phosphate Mining Co., The, New York City.	4
Polk Co., R. L., Detroit, Mich.	—
Potash Co. of America, New York City.	3rd Cover
Raymond Bag Co., Middletown, Ohio.	16
Ruhm, H. D., Columbia, Tenn.	34
Sackett & Sons Co., The A. J., Baltimore, Md.	—
Schmaltz, Jos. H., Chicago, Ill.	34
Shuey & Company, Inc., Savannah, Ga.	34
Southern Phosphate Corp., New York City.	24
Stedman's Foundry and Machine Works, Aurora, Ind.	20
Stillwell & Gladding, New York City.	34
St. Regis Paper Co., New York City.	Back Cover
Tennessee Corporation, Atlanta, Ga.	22
Texas Gulf Sulphur Co., New York City.	—
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.	27
United States Potash Co., New York City.	2nd Cover
Utility Works, The, East Point, Ga.	—
Wellman, William E., Baltimore, Md.	27
Wiley & Company, Inc., Baltimore, Md.	34

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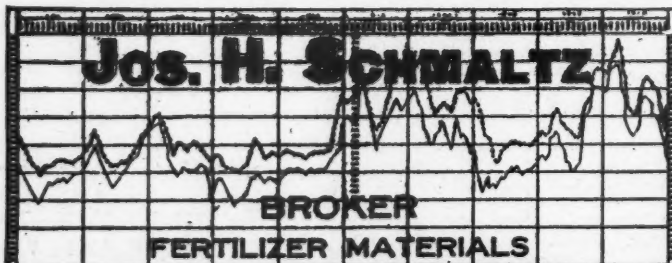
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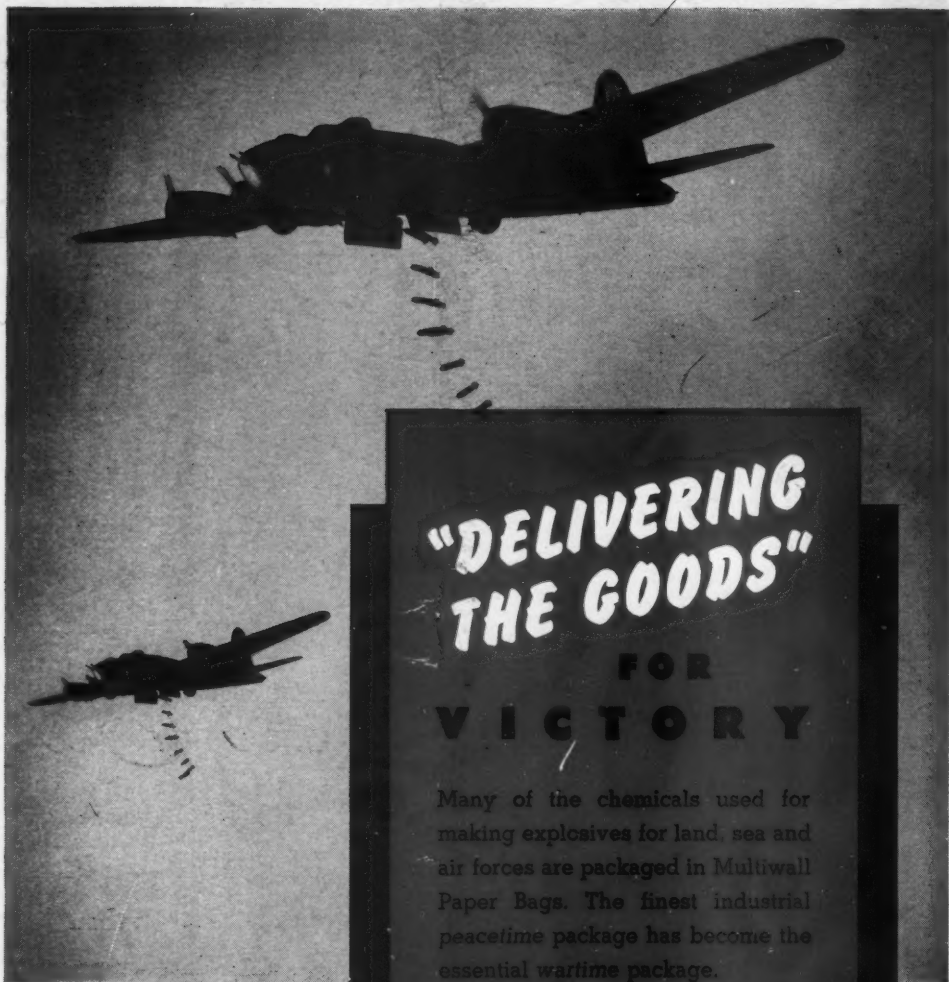
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